Project Inquiry: An NSF-Funded Professional Development Model for Promoting Scientific Inquiry in Middle Level Classrooms

Ann Wallace
College of Charleston
School of Education
66 George St
Charleston, SC 29424
843-953-7372
wallacea@cofc.edu

Daniel Dickerson
College of Charleston
School of Education
66 George St
Charleston, SC 29424
843-953-0897
dickersond@cofc.edu

Meta Van Sickle
College of Charleston

Carol Tempel
Charleston County School District

Pam Coffey
Berkley County School District

Sara Powell
College of Charleston

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Introduction

Developing a nation of scientifically literate people has never been more important than it is now that we have entered the twenty-first century. Science enables people to creatively problem solve and to understand the natural world. Unfortunately, critiques of science education (National Center for Education Statistics, 1999) have consistently reported that the achievement of American students is less than that of their international counterparts in the areas of science and mathematics. These results indicate a strong need for the United States to re-examine science and mathematics education. Spillane (2001) states that in response to this report the National Research Council (NRC) published the *National Science Education Standards* (NSES) in 1996. These standards were written to characterize goals for reform in science education by describing what it would mean to be scientifically literate in today's society and to provide guidance to those involved in changing science curriculum and teaching. This document offered a challenge for educational reform and provided a framework for its construction by calling for dramatic changes in science teaching throughout our nation.

The South Carolina Department of Education (2000), as well as numerous other state departments of education, responded to this call by incorporating the *NSES* into their own state science standards with particular emphasis on inquiry-based process skills and pedagogy. One immediate result of the implementation of standards-based curriculum was the need for professional development opportunities designed to address both the content knowledge of teachers and effective use of inquiry-based instructional strategies.

This need, as well as the need to effectively address the achievement gap between African American and white students regarding science achievement, provided the impetus for the development and implementation of Project Inquiry (#ESI-99868690), a $5,180,000 five-year, National Science Foundation (NSF) funded grant based in the Berkeley and Charleston County School Districts of South Carolina. In an effort to communicate with other stakeholders interested in the professional development of middle level teachers, we describe in this paper the middle school portion of the collaborative program model implemented in these two South Carolina school districts.

Theoretical Framework

The National Science Teachers Association (NSTA) addresses major elements including needs of young adolescents, model programs, model teachers, necessary resources, and professional interactions in their standards for teacher preparation (NSTA, 2003). "The standards state that science is something students do, with inquiry central to science learning" (Powell, 2005, p.159). The theoretical framework used in the design and execution of the programmatic components of this project incorporates NSTA elements in order to make science something students ***do***. A primary focus is the structure, function, and content of professional development opportunities for in-service science teachers that will lead to inquiry-based instructional approaches for the teaching of science.

Current reform movements in science education advocate for the development of science inquiry classrooms, where students combine processes and scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of

science (NRC, 1996). One inquiry approach to science teaching is based on the view that students learn by resolving discrepant events that challenge their current conceptual understanding. Students demonstrate their understanding by making choices during scientific inquiry and then providing rationales for those choices rather than simply following procedural instructions provided by the teacher (see for example Bonnstetter, 1998; Crawford, 2000; Edelson, 2001; Park, 2002; Yerrick, 2000). This example of an inquiry-based approach is much different from how teachers themselves learned science, as well as how most had been teaching science.

Both the initial middle level teacher preparation standards and the master teacher standards of the National Middle School Association address teacher content knowledge and classroom curriculum, instruction, and assessment. Standard four is entitled "Middle Level Teaching Fields" and calls for teachers to "understand and use the central concepts, tools of inquiry, standards, and structures of content in their chosen teaching fields" and to "create meaningful learning experiences that develop all young adolescents' competence in subject matter and skills" (NMSA, 2002, p.11). Standards three and five address appropriate concepts and strategies for middle level curriculum, instruction, and assessment. Professional development serves as a critical element in the facilitation of teachers learning content in greater depth and breadth along with ways to implement inquiry-based teaching approaches in curriculum, instruction, and assessment.

Professional development of teachers in science education can be described as opportunities offered to educators to develop new knowledge, skills, approaches, and dispositions to improve their effectiveness in their classrooms and organizations. Commonly known as in-service training, professional development historically was

delivered through workshops that concentrated on conveying information, providing ideas, and training in various skills. This approach to professional development offers teachers an assortment of resources, but often teachers' learning ends with the completion of the program rather than continuing every day in their classrooms. More recently, professional development has evolved to focus on sustained individual growth and a more systemic, integrated perspective on enhancement across cohorts of teachers (see for example Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 1998; Westerlund, Garcia, Koke, Taylor, & Mason, 2002). Program designers for Project Inquiry seriously considered this evolution and incorporated many of the insights gained into a unique model that employs many of the components currently considered to be best practice in professional development.

Program Model

Like other programs (see for example Brand, 2002; DiBiase, Riley, Cathey, & Nattaradol, 2002; Lomask & Brown, 2002), the professional development experiences of Project Inquiry focus on improving teacher use of inquiry-based instructional strategies. A dynamic, state of the art design that incorporates several novel components is implemented to reach the primary goal of the program, to improve the science literacy of all students in the Berkeley and Charleston County School Districts by encouraging teachers to choose their path to best practice for their classroom. Program leaders aimed to meet this goal through a system-wide science improvement plan that includes the completion of 135 hours of professional development in inquiry-based content and pedagogy by third- through eighth-grade classroom science teachers. More specifically,

the Project Inquiry plan consists of: 1) enhancing teachers' science content knowledge; 2) familiarizing teachers with effective instructional materials and helping them learn appropriate pedagogy to develop students' conceptual understanding of science; and 3) providing ongoing support as teachers use the instructional materials in their classrooms.

Enhancement of Content and Pedagogical Knowledge

Project Inquiry has employed a multifaceted approach to improving instruction, and consequently achievement, in science classrooms. The professional development approach began with the adoption of several science programs, such as the Science and Life Issues (SALI) and Science Education for Public Understanding Program (SEPUP) kits which provide an integrated curriculum that focuses on hands-on investigations, environmental issues, technology, higher order thinking skills, and cooperative learning. Each module provides teachers with in-depth science content background as well as information about scheduling the activities and organizing the classroom and students for effective implementation. They also use Full Option Science System (FOSS) activities to provide experiences for students to observe, describe, sort, and organize ideas about objects and organisms. They classify, test, experiment, and determine cause-and-effect relationships. The middle level FOSS kits also promote the use of cooperative group work involving students in the collection and analysis of data and the reporting of group results. FOSS (Lawrence Hall of Science, 1995) has two major goals:

1. Scientific Literacy – to provide all students with science experiences that are appropriate to their cognitive stages of development and serve as a foundation for

more advanced ideas that prepare them for life in an increasingly complex scientific and technological world.

2. Instructional Efficiency – to provide teachers with a complete, flexible, easy-to-use science program that reflects current research on learning and the latest instructional methodologies.

These goals support inquiry teaching and all the kits provide teachers with a hands-on, ready-to-implement curriculum that is combined with other inquiry-based instructional strategies. Project Inquiry periodically assesses the combination of instructional materials and strategies for effectiveness.

To support the use of national and state science standards in the classroom, Project Inquiry offers Science Inquiry Institutes, Assessment Institutes, and Science Standards Institutes that provide teachers with 135 hours of professional development. The Science Inquiry Institutes provide professional development experiences modeled after San Francisco's Exploratorium. During these institutes, participants learn about and acquire the tools necessary for applying inquiry approaches in instruction. Sessions are characterized by considerable focus on student thinking and learning as well as the types of activities and strategies best suited for inquiry approaches to science education.

One of the more novel components of the program includes teachers learning science content through the use of the same strategies that they will eventually use with their students such as authentic science investigations and class discussions. Teachers also learn inquiry process skills and practice those skills through problem solving activities. The Science Standards Institutes are organized by grade level with participants addressing the South Carolina science content and process standards.

Project Inquiry also includes science content graduate courses. These courses are interdisciplinary science courses taught at the College of Charleston that provide teachers with formal opportunities to learn science concepts in the fields of geology, biology, chemistry, and physics. Examples of course offerings include: Applications of Physics for Teachers, Space Science for Teachers, and Topics in Botany for Teachers. Teachers are very enthusiastic about these courses and find they match the state curriculum standards and help them to understand the science content as described in the Content Standards: 5-8 of the *NSES* (National Research Council, 1996).

Long-Term Support

Professional development models that expect teachers to implement and sustain classroom changes with no support from administrators or peers are nearly impossible to sustain. Administrative support is crucial for the survival of the project. Project Inquiry provides training for school-level administrators to familiarize them with their role in supporting teachers' efforts to implement hands-on science. Expected support includes helping teachers reflect on their practice; building networks so that teachers can learn from each other; keeping the focus on staff development for enough time to permit teachers to internalize the change; helping teachers overcome conditions that may work against the continued development of the focus of the staff development; facilitating dialogue and communication among teachers; providing time for trained observers to monitor progress in the schools; and providing a sounding board for problems (Friel & Bright, 1997). Additional administrative support comes in the form of the districts providing teachers with needed materials and equipment as well as the means to maintain

those resources. For example, to maintain consumable items found in the kits, the Science Resource Center, established by Project Inquiry, refurbishes kits and distributes them to schools in accordance with an established schedule.

Program leaders consider on-site specialists to be critical to successful long-term reform efforts in schools. Consequently, all Project Inquiry schools are assigned a Lead Science Teacher (LST) who serves as the contact person between the school, the Science Resource Center, and the project directors. These on-site specialists also coordinate the distribution of kit materials in their schools and conduct focus seminars, grade level meetings, and professional development activities with the teachers in their schools throughout the year. Additionally, Project Inquiry program leaders provide LST's training in coaching and mentoring skills during Leadership Academies for a total of 180 hours of professional development. The LST's employ these skills in helping teachers examine their own practice and reflect on ways to enhance classroom instruction. A Science Resource Teacher (SRT) is assigned a set of schools with which to work in the implementation of the designated materials. The SRT's primary job is to design professional development and to support teachers in their implementation of an inquiry approach to science through mentoring, modeling lessons and use of science notebooks, coaching, and one-on-one training. These support strategies occur in the contexts of countywide workshops, institutes, and individual classroom visits.

Summary

The purpose of the Project Inquiry's use of science kits with accompanying professional development is to challenge middle level teacher beliefs about the teaching

and learning of science and, in turn, impact their instruction in positive ways. The program is designed to address teachers' professional knowledge and resources rather than simply adding recipe-like teaching procedures to their repertoire. Throughout the many and diverse institutes, teachers are presented with challenging hands-on inquiry-based problem situations with institute instructors using approaches and framing instruction in ways similar to what participants would eventually implement in their own classrooms. Using professional development institutes geared toward adult learning, providing a variety of hands-on activities and resources, and ensuring long-term support for teachers, Project Inquiry serves as a model for advancing effective inquiry-based science instruction in middle level classrooms.

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